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Rollover Protection Systems

Model: E36iC, E46iC, E64

Production: All with convertible top

OBJECTIVES

After completion of this module you will be able to:

- Understand RPS operation
- Diagnose RPS concerns
- Perform Reset procedures
- Perform RPS system checks

Rollover Protection Systems

The Rollover Protection System (RPS) was developed to provide an adequate survival space in the event of an accident involving a rollover. This system is used on convertibles as an enhancement to the existing safety systems.



There are several different factors which can cause a vehicle to roll over. The most common causes are:

- The vehicle can leave the roadway and travel along a gradient. This can cause the vehicle to roll if the “tilt” is excessive.
- The vehicle can contact a crash barrier at a severe angle. The barrier can act as a ramp which also creates the potential for a rollover.
- The vehicle can skid laterally off the road surface and bury its wheels in a soft surface. The prevailing kinetic energy could be sufficient to overturn the vehicle
- The vehicle skids laterally off the road surface and contacts a curb or stationary object which can result in the vehicle being upended.

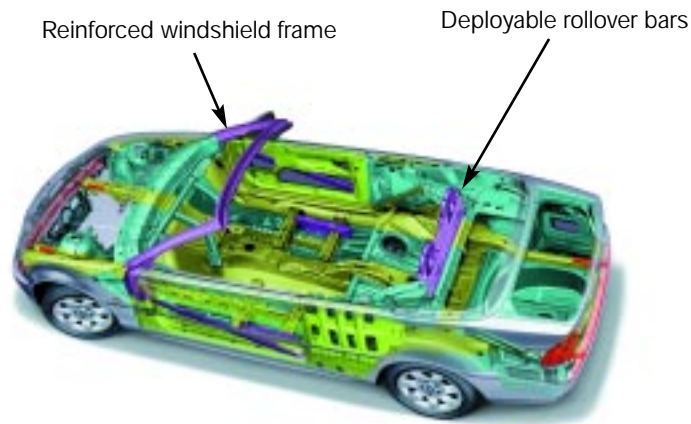
The crucial factors which determine whether the vehicle overturns are not just the angle of the vehicle, but also the speed at which the vehicle approaches the potential event.

There are two types of rollover protection used on BMW vehicles. One system is a set of rigidly fixed rollover bars used on BMW roadsters. These vehicles include the Z3, Z4 and the Z8. All of these vehicles use a set of fixed bars which are bolted or welded to the vehicle.



The second type of rollover protection system used consists of a set of automatically deployable rollover bars. These bars are used in conjunction with a reinforced windshield frame. These two features work together to provide a survival space for the occupants in the event of a rollover.

E46 Cabriolet



The automatic rollover bars are controlled by a system which monitors the angle of the vehicle as well as g-forces acting on the vehicle. Once these threshold values are exceeded, the rollover bars are deployed.

The rollover bars are held in the retracted position against a spring force. They are deployed by electrically releasing the solenoids which are holding the bars in place. When the bars are released, they are held in position by a locking pawl which uses a toothed ratcheting mechanism.

The toothed mechanism can be released to restore the bars to the retracted position. If the bars are not damaged, they can be reset and re-used.

Each RPS system, depending upon vehicle application, has a mechanical release procedure as well as a mechanical resetting procedure for service personnel. (These topics will be covered later in this training module).



E46 Convertible



E64 Convertible

The vehicles discussed in this training module are those using the automatically deployable rollover bars. This system is referred to as the Rollover Protection System or RPS. Another term used for RPS is URSS. This is an abbreviation for the German words **Über Roll Schutz System**. This term may be used in some technical reference documents or diagnostic equipment test modules.



E46 with rollover bars deployed



E46 with rollover bars deployed



E64 with rollover bars in retracted position



E64 with rollover bars deployed

These vehicles, which are all convertibles, include the E36iC, E46iC and the E64. All of these vehicles use RPS. Each version differs slightly in function and operation.

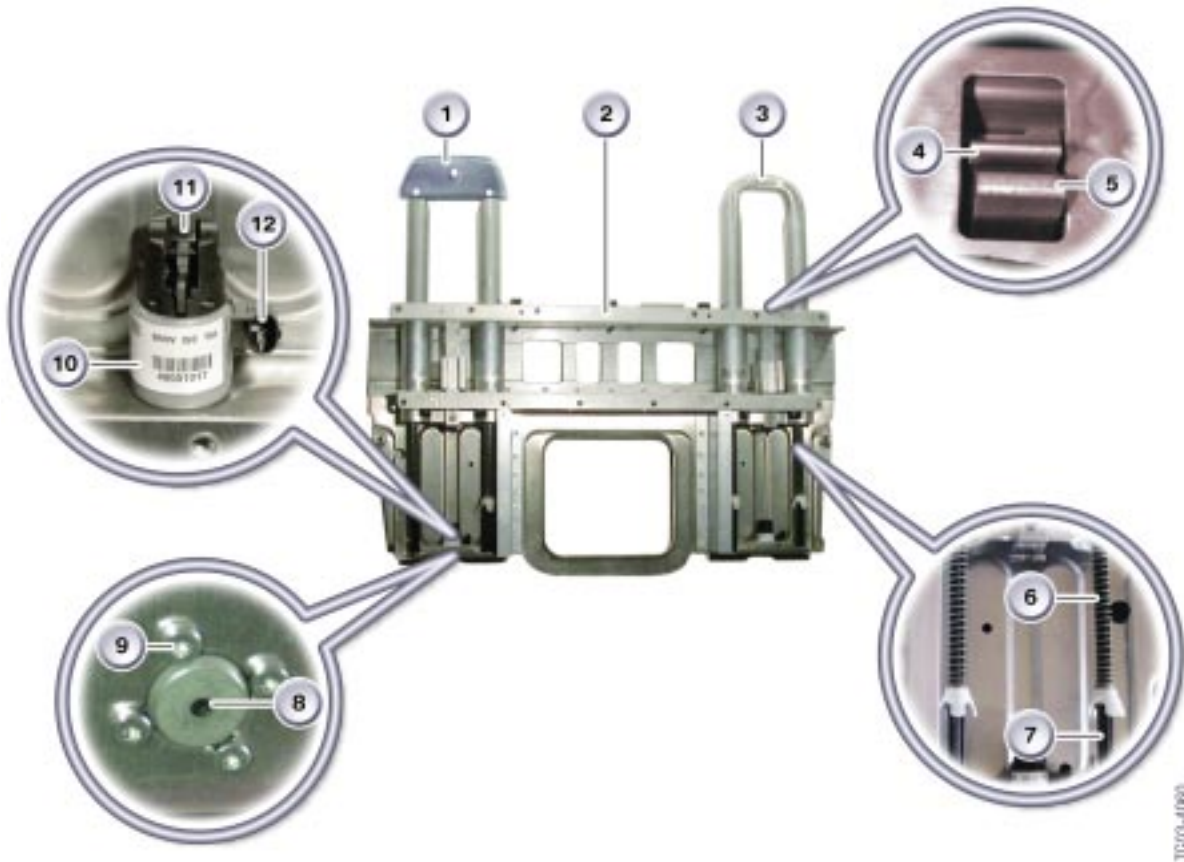
The E36 and E64 each have a set of rollbars which are mounted behind the rear headrests. The E46 has a set of rollbars which are deployed through a retractable cover on the rear headrests.

E64 Rollover Protection

Components

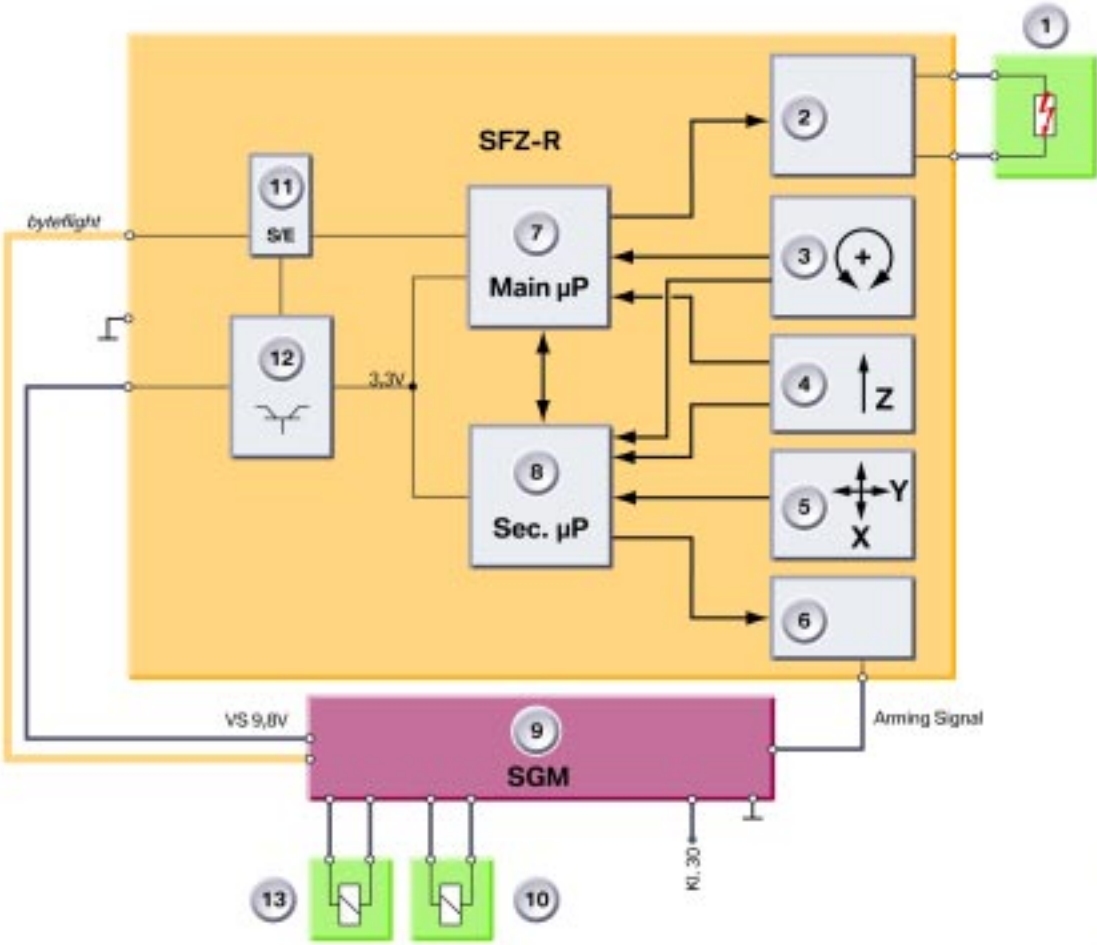
On the E64, the two extending rollover bars are housed behind the rear seats in a carrier structure. Unlike the RPS on the E36/E46 Convertibles, the sensors for rollover detection are located in the vehicle center satellite SFZ-R.

The rollover protection system consists of the following components:



Index	Explanation	Index	Explanation
1	Cover, rollover protection bar	7	Guides
2	Support structure	8	Opening for emergency release
3	Rollover protection bar	9	Actuator retaining screws
4	Locking pawl	10	Actuator
5	Toothed strip	11	Lock
6	Preload spring	12	Electrical connection

The additional sensors for the rollover protection system have been incorporated into the SFZ-R. The SFZ-R is located in the center console area and is connected to the SGM via *byterflight*. Any positional changes of the vehicle can be precisely monitored and recorded due to the central location of the satellite.



Index	Explanation	Index	Explanation
1	Safety Battery Terminal (BST)	8	Secondary (auxiliary) processor
2	BST output stage	9	Safety and Gateway module
3	Yaw-rate sensor	10	Actuator, right
4	Low-g sensor	11	Transmitter/receiver module
5	Longitudinal and lateral acceleration sensor	12	Voltage regulator
6	Arming signal interface	13	Actuator, left
7	Main processor		

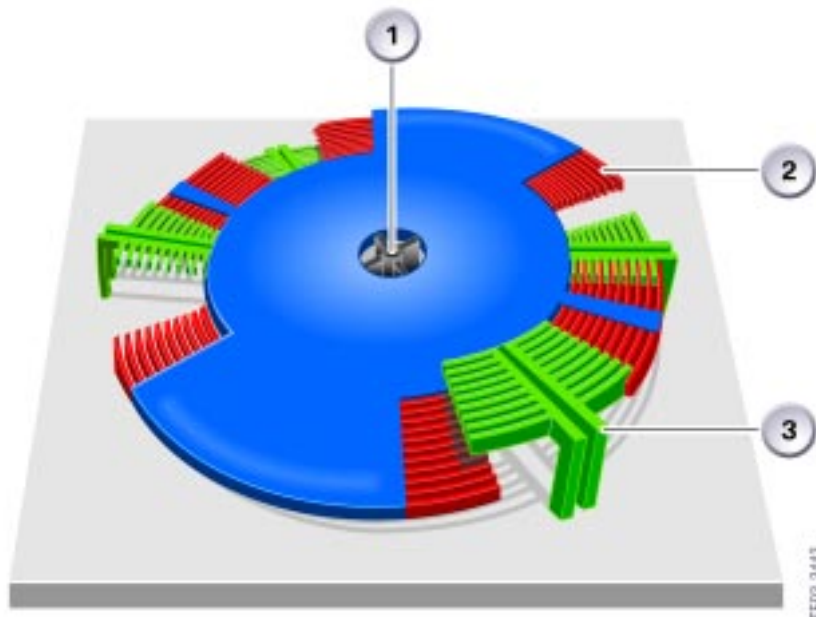
The following sensors are incorporated into the SFZ-R:

- Longitudinal acceleration sensor (X-axis)
- Lateral acceleration sensor (Y-axis)
- Low-g sensor (Z-axis)
- Yaw-rate sensor (rotation in the X-axis)

The longitudinal and lateral acceleration sensors record the positive and negative vehicle acceleration. The sensors provide a voltage signal proportional to the acceleration. The voltage signal is evaluated by the SFZ-R and this information is sent to the SGM and the other satellites via **byteflight**.

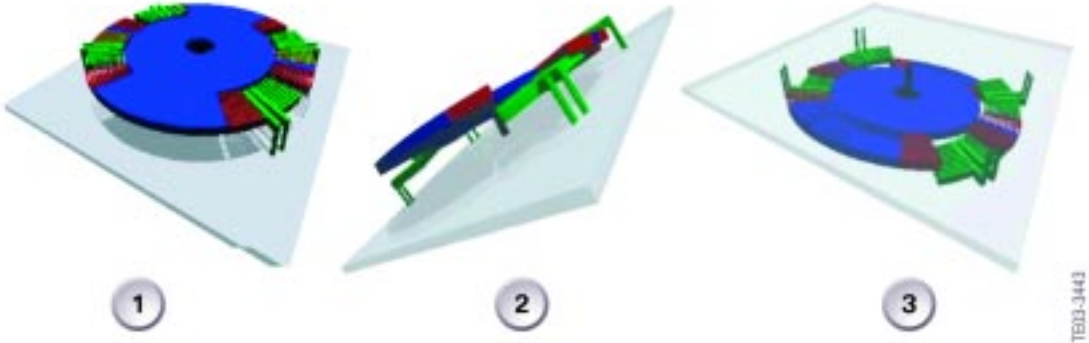
The Low-g sensor records the acceleration in the Z-axis (vertical).

The rollover sensor is similar in design to a yaw-rate sensor. The yaw-rate sensor has a “comb-like” structure, which consists of a fixed comb structure and a rotational oscillator with a moving comb-structure. Together, the comb structures form a capacitor. The rotational oscillator is fitted on bearings on an axle in its center.



Index	Explanation
1	Rotational Axis
2	Rotational oscillator with moveable comb structure
3	Fixed comb structure with signal pickups

When the vehicle is in a horizontal position (1), the rotational oscillator turns with the comb structure and detects the change of direction (L/R). If the vehicle is brought into a tilting position (2), the rotational oscillator is moved out of the comb-structure due to the Coriolis effect.



Index	Explanation
1	Rollover sensor in original position (flat surface)
2	Rollover sensor in tilted position (slope, crash barrier)
3	Rollover sensor in original position (180° rollover)

This causes a change in capacitance, which in turn creates a proportional change in voltage in the millivolt range. This is evaluated as the measured variable. The voltage change is directly related to the angle and in the same way, the speed of the voltage change is directly related to the angle velocity. The angle and the angle velocity are the measurements used for the algorithm calculation.

The SFZ-R incorporates two processors, a main processor and an auxiliary processor for calculating rollover-detection data.

The main processor contains the algorithm for calculating rollover tendency. The data from the yaw-rate sensor and the low-g sensor are used for this purpose.

The longitudinal and lateral acceleration sensors, the yaw-rate sensor and the low-g sensor are evaluated in parallel in the auxiliary processor.

The data is exchanged between the two processors. If, in the event of an imminent rollover, both processors arrive at the same result, the following sequence is initiated:

- The main processor sends the data to the SGM via **byteflight**.
- The main processor activates the arming lead to the SGM.
- The SGM combines and compares both items of information.
- If the stored threshold values are exceeded both actuators are activated.
- The actuators release the lock and the rollover protection bars emerge under spring pressure.

Triggering Sequence

In normal operating mode, the rollover bars are retracted in the support structure. They are preloaded by spring pressure and held in place by a lock on the actuators.

If the rollover sensor in the SFZ-R detects an imminent rollover, data is sent via byteflight to the SGM. At the same time, the signal to enable the RPS (URSS) is sent to the SGM via a copper cable (arming wire). The SGM then activates the two actuators via the output stage.

The RPS system may be triggered in the following situations:

- Automatically when an imminent rollover is detected
- By a defined accident severity in a front, side or rear end collision.
- Via the diagnostic interface (DISplus/GT-1)
- By a mechanical emergency release mechanism

The RPS system will be triggered along with other safety systems during a rollover as follows:

Accident Severity 1	Accident Severity 2
Rollover protection system	Rollover protection system
Central locking	Central locking
Hazard warning lights	Hazard warning lights
Interior light	Interior light
	BST
	Seatbelt tensioners
	Electric fuel pump cutout
	Emergency telephone call (optional)

URSS Service Information

Activation of the rollover protection devices is possible through a Test Plan of the DISplus or GT1.

During Test plan activation observe the following safety precautions:

- The convertible top **MUST** be in the down position (Top Open)
- **DO NOT** stand over or near the rollover protection devices prior to or during deployment

Mechanical Deployment (For Service)

Prior to servicing, repairing or removing the URSS the rollbars must be deployed. If it is not possible to activate the system with the DISplus or GT1, the emergency mechanical release should be used.

1. Open the Convertible top
2. Trunk open
3. Remove the baggage compartment floor mat and bulkhead cover
4. Insert a hook device into the opening of the crossmember until you reach the actuator
5. Insert the hook (allen key) into the hole in the actuator and pull the release lever



Workshop Exercise - URSS Deployment

Mechanical Deployment

Using an instructor designated vehicle (E64). Perform the mechanical release of the rollover bars. Prior to servicing, repairing or removing the URSS the rollbars, they must be deployed. If it is not possible to activate the system with the DISplus or GT1, the emergency mechanical release should be used.

With the Instructor's assistance:

- 1. Open the Convertible Top.*
- 2. Trunk open.*
- 3. Remove the luggage compartment floor mat and bulkhead cover.*
- 4. Insert an "L" shaped device (allen key) into the opening of the bulkhead cross member until you reach the actuator.*

Note: DO NOT stand over or near the rollover protection devices prior to or during deployment.

- 5. Insert the tool into the base of the actuator (hole) and push up.*

To Reset:

- 6. Slide the release latch (under the deployed bar) and slowly compress the bar (approximately half way) remove your hand and fully down seat the bar until it latches.*

DISplus/GT1 Deployment

Activation of the rollover protection devices is possible through Service Functions > Test Plan in the DISplus or GT1.

During Test plan activation observe the following safety precautions:

- 1. The convertible top MUST be in the down position (Top Open).*

Note: DO NOT stand over or near the rollover protection devices prior to or during deployment.

- 2. Slide the release latch (under the deployed bar) and slowly compress the bar (approximately half way) remove your hand and fully down seat the bar until it latches.*



Classroom Exercise - E64 Rollover Protection

1. Which component controls the rollover bar actuators on the E64?

2. On the E64, what sensors does the SFZ-R contain which pertain to rollover detection?

3. What is the Low-g sensor used for?

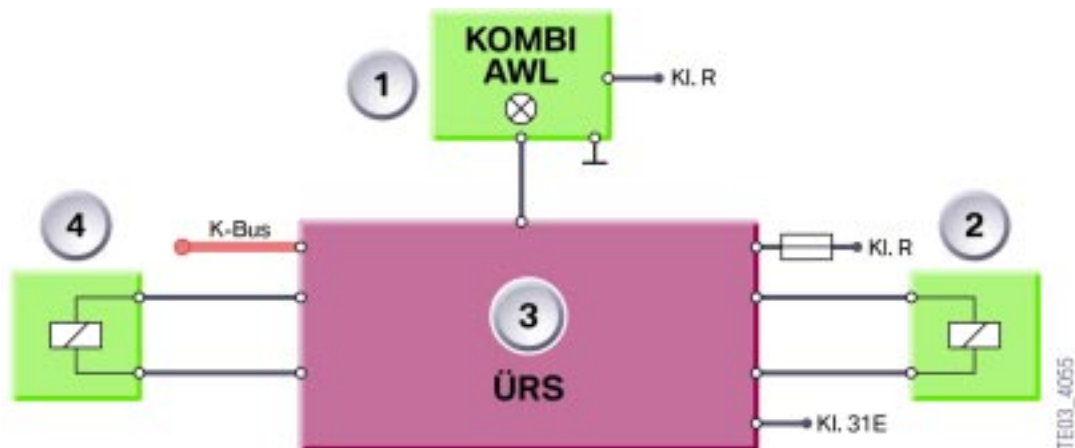
4. What is the purpose of the arming wire?

5. List the 4 situations in which the rollover bars can be deployed:

E46 Rollover Protection System

RPS on the E46iC, although similar to the E64, is derived from the E36. This system uses a separate rollover sensor (URS) which directly controls the actuator circuits. The URS is connected to the K-bus for diagnosis and for transfer of information to and from the MRS system.

As with all Rollover protection designs, the vehicle also incorporates a reinforced windshield frame.



Index	Explanation	Index	Explanation
1	Instrument cluster	3	Rollover sensor
2	Crash actuator, right	4	Crash actuator, left

System Components

Roll Over Bar Cassettes

The roll over cassettes are new and constructed completely from aluminum with a pad integrated in the top of the bar. The cassettes are bolted into the reinforced carrier behind the seat back. When retracted, they are covered by the rear head rest which incorporate a flap, at the back, that will open when the roll bars deploy.

Actuator Solenoids

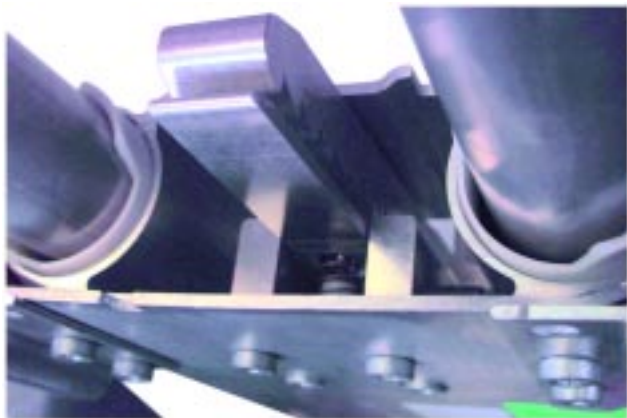
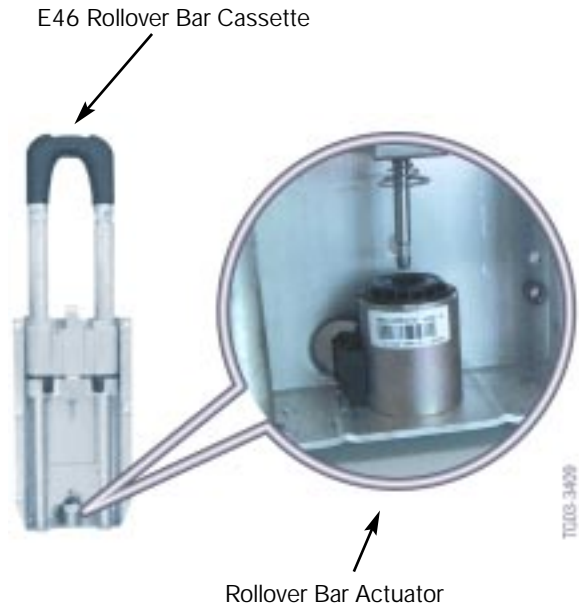
A newly designed solenoid, mounted in the bottom of the cassette, holds the bars in the retracted position until triggered by the roll over sensor for deployment.

Each actuator consists of a single acting solenoid with a lock for disengaging and engaging the rollover protection bar.

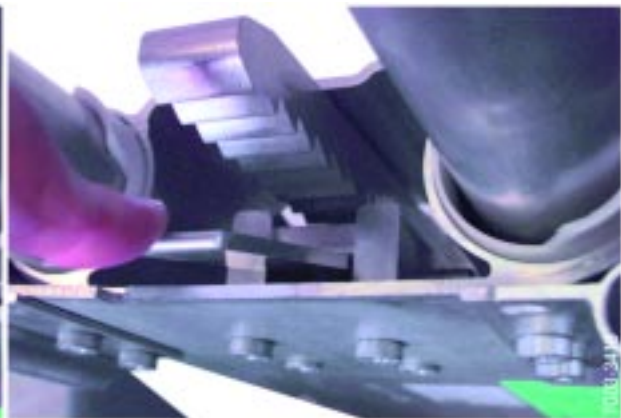
The bar, when triggered, will extend within 300ms.

The locking pawls on the rollover bar press the toothed strip back mechanically as the bar extends. When the protection bar is extended, the locking pawls are supported on the toothed strip. When the car is in the overturned position, the force is transmitted via the locking pawls on the rollover bars to the toothed strip.

The retaining hook illustrated below must be held back in order to return a triggered rollover bar to its original position. Then the rollover bar can be reset without the use of a special tool as in the case of the E36.



Retaining hook engaged



Retaining hook released

Roll Over Sensor

The rollover sensor which contains the clinometer and the G-sensor is installed in the rear behind the right rear seat back on the rollover cassette. It also contains the processing electronics for rollover detection and deployment final stage for triggering the rollover bar solenoids.



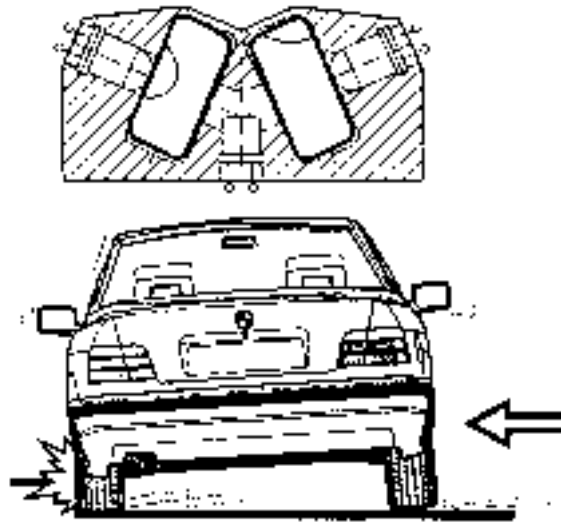
Two capacitors are also installed for roll bar deployment in the event of a power failure with the system during an a crash. The sensor is connected to the diagnostic link for troubleshooting purposes.

The sensor performs a self check every time the ignition is switched on. If any faults are detected, the warning lamp in the cluster will illuminate. If possible, the system will trigger the solenoids even though a fault is stored in the fault memory.

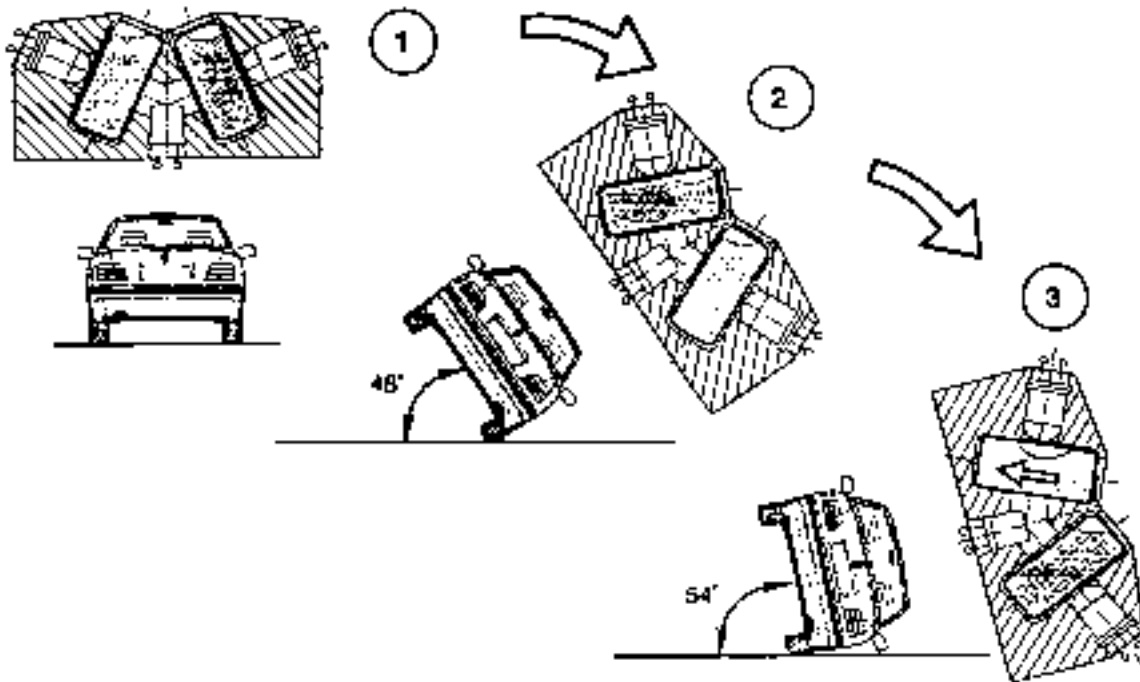
Note: The rollover sensor must be in the installed position when the power supply is switched on. If the rollover sensor is not in the normal position during the self test (which is performed after switching on), bubble level and g-sensor faults may be detected by the self test. A sensor (bubble level or g-sensor) which is detected as being faulty is blocked from the triggering process.

Clinometer

The clinometer inside the sensor consists of three level floats to detect body tilting, transverse and longitudinal acceleration for roll bar deployment. Two floats are positioned on opposing angles of 52 degrees to the horizontal axis of the vehicle. The third float is positioned at an angle of 72 degrees to the longitudinal axis. LED transmitters and phototransistor receivers are positioned to read the air bubble float as it moves in the glass tube.

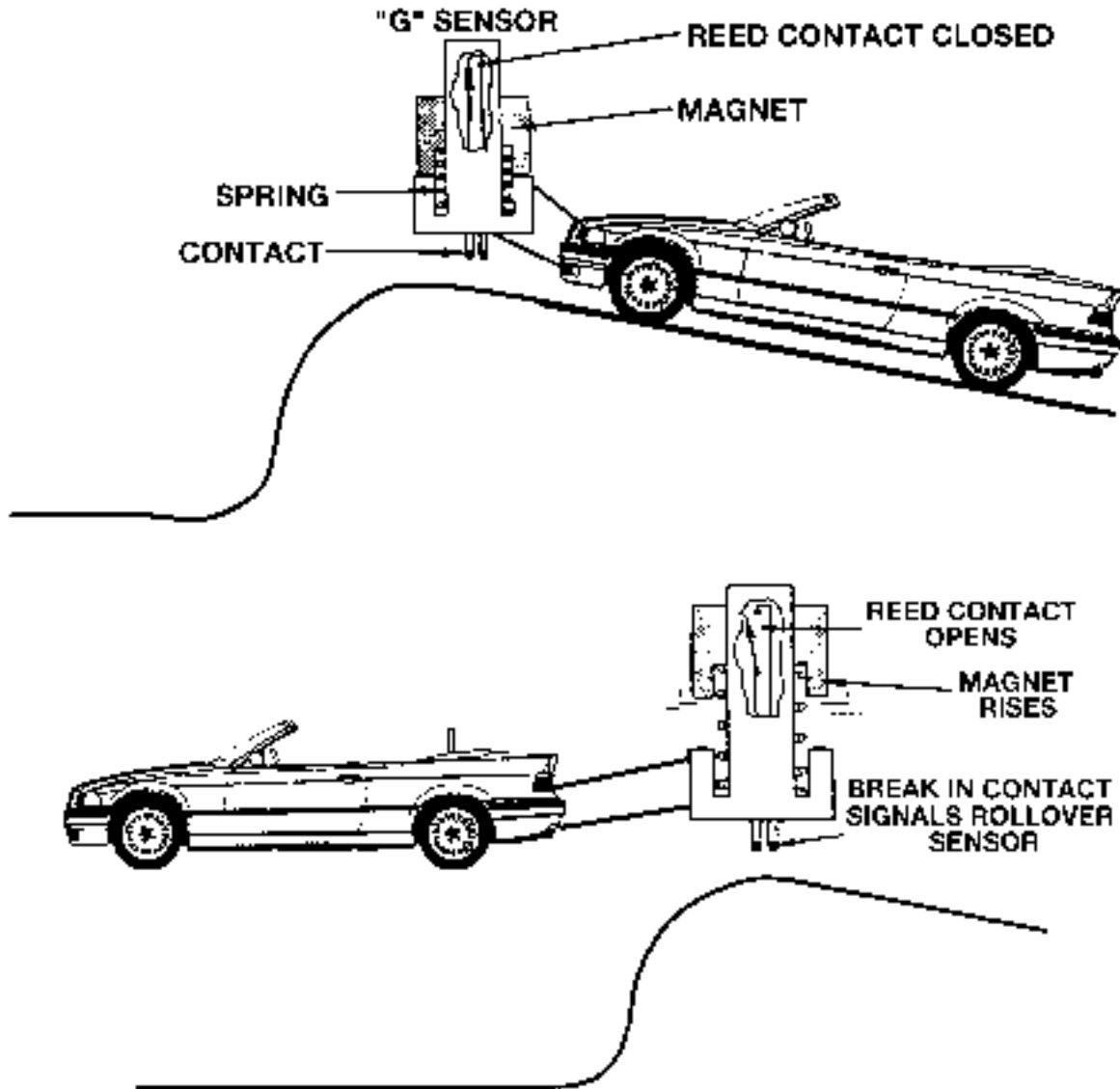


If the vehicle starts to roll over sideways or end-to-end, beyond the critical angles, the air bubble will move and interrupt the LED signal. The electronics of the sensor will then trigger the solenoids and the roll bars will deploy.



"G" Sensor

The "G" sensor is used to trigger the roll bars if the vehicle should become airborne. the "G" sensor consists of a reed contact, magnet and spring assembly. As long as the vehicle is in contact with the road surface, the spring does not have enough tension to overcome the weight of the magnet and gravity.



However, if the vehicle becomes airborne and weightlessness occurs, the spring will force the magnet up and the reed contact will open. This will signal the electronics of the sensor to trigger the solenoids and the roll bar will deploy.

A time period of approximately .3 seconds with a "G" force of approximately 0.9 or less is required before the bars will deploy.

Roll Over Sensor Diagnosis and Testing

The sensor performs a self check every time the ignition key is switched on. All components of the sensor are checked including the output stages for roll bar triggering. If a fault is detected, the warning lamp in the cluster is illuminated and the fault is stored in the memory of the convertible top module.

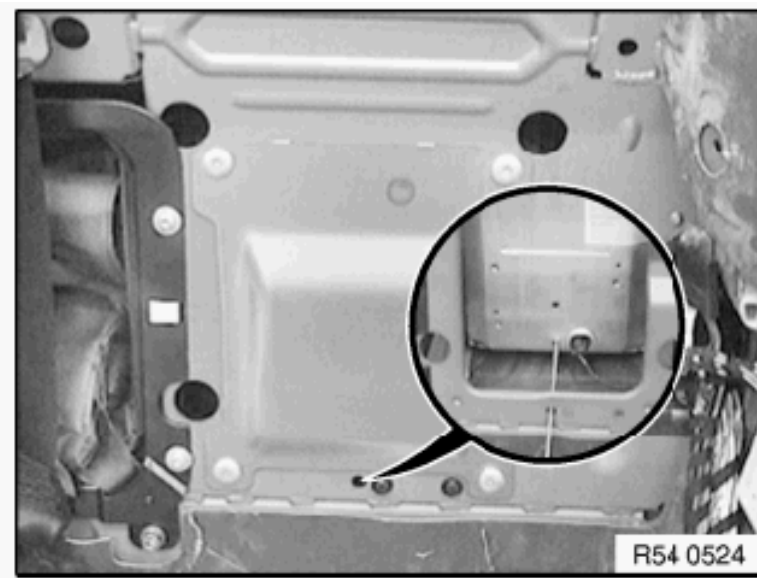
In the event of a power failure, capacitors in the sensor can still trigger the solenoids for approximately 5 seconds.

The RPS system must be checked at various service intervals, refer to the latest inspection sheet for the proper intervals.

Servicing Rollover Bar Cassettes

The rollover bar cassettes cannot be repaired. They can only be replaced. In the event that replacement becomes necessary, the cassettes must be released before attempting to remove.

This can be done by using the diagnostic equipment (DISplus/GT-1) or via mechanical means. When using the diagnostic interface, use the service functions menu.



When using the mechanical method, remove the rear seat (upper) as necessary to access the rear side of URS. Insert a 4mm punch or equivalent into access hole and release rollover bars.



Workshop Exercise - E46 RPS

Mechanical Deployment

Using an instructor designated vehicle (E46). Perform the mechanical release of the rollover bars. Prior to servicing, repairing or removing the URSS the rollbars, they must be deployed. If it is not possible to activate the system with the DISplus or GT1, the emergency mechanical release should be used.

With the Instructor's assistance:

- 1. Open the Convertible Top.*
- 2. Remove upper backrest to expose access hole*
- 3. Using 4mm punch or equivalent release rollover bars.*

Note: DO NOT stand over or near the rollover protection devices prior to or during deployment.

To Reset:

Slide the release latch (under the deployed bar) and slowly compress the bar (approximately half way) remove your hand and fully down seat the bar until it latches.

DISplus/GT1 Deployment

Activation of the rollover protection devices is possible with the DISplus or GT1.

During Test plan activation observe the following safety precautions:

- 1. The convertible top MUST be in the down position (Top Open).*

Note: DO NOT stand over or near the rollover protection devices prior to or during deployment.

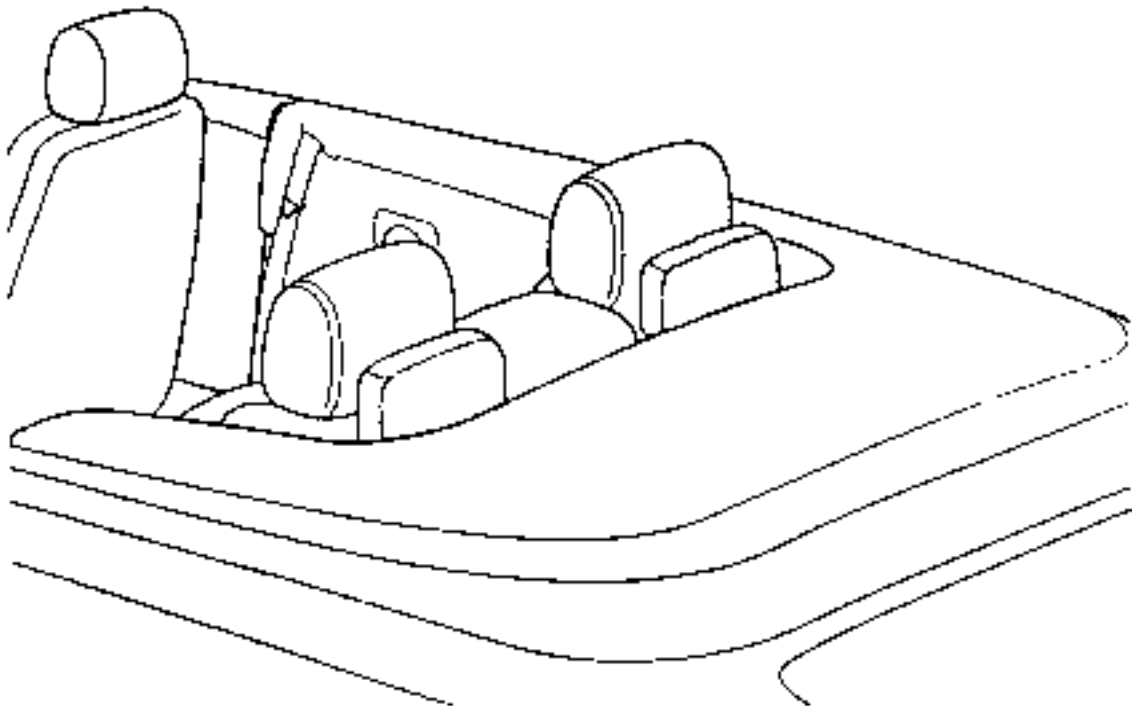
- 2. Slide the release latch (under the deployed bar) and slowly compress the bar (approximately half way) remove your hand and fully down seat the bar until it latches.*

E36 Rollover Protection

The first BMW convertible to use RPS was the E36. The system uses a pair of deployable rollover bars which lock into position to protect the occupants during a rollover.

As with all vehicles equipped with rollover protection, a reinforced windshield frame supplements the RPS.

This system uses a rollover sensor located behind the left backrest. Faults with the rollover sensor will cause an RPS warning light in the cluster to illuminate. The rollover sensor is connected to the data link for access to diagnostics as well.



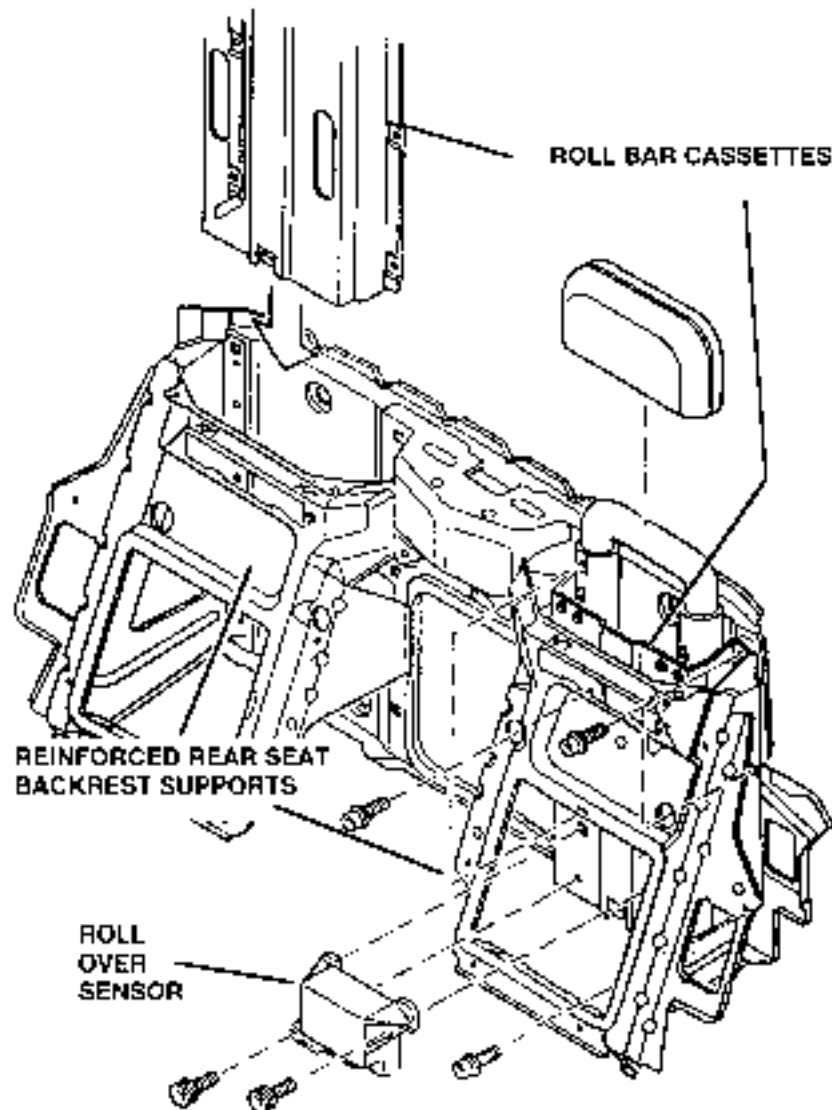
The rollover bars can be reset by means of a special tool located in the vehicle tool kit. Also the bars can be mechanically deployed or by means of the diagnostic test equipment (DISplus/GT-1). This procedure is necessary to remove the rollover bars in the event that service or replacement is required.

System Components

Roll Bar Cassettes

Two roll bar cassettes are located in a reinforced body structure behind the rear seat backrests. Each assembly consists of a U-shaped bar that is guided by low-friction plastic bushings. The bar is held in the retracted position against spring pressure by a lever. The lever is solenoid controlled to unlock the rear bar for deployment. The two springs ensure that the bar will deploy quickly to provide adequate protection.

When deployed, the bar is held in place by a ratchet and lever assembly that locks the bar in the raised position.



Each rollover bar cassette is a self-contained unit which can be replaced separately if needed. The bars are constructed of light alloy steel and weigh approximately 11 lbs. each.

During a rollover the bars have the capability of absorbing 35KN each.

If the bars are damaged or malfunction during the maintenance procedures, the bars should be replaced. No repairs are allowed on the bars whatsoever.

If replacement is required, the bars must be in the deployed position before starting work.

The bars can be deployed via mechanical means or by the diagnostic equipment.

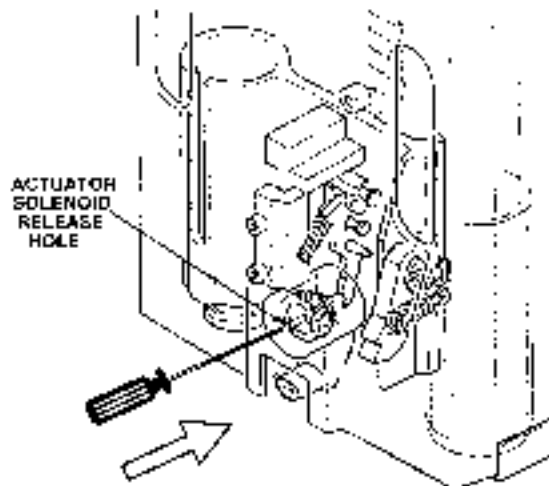
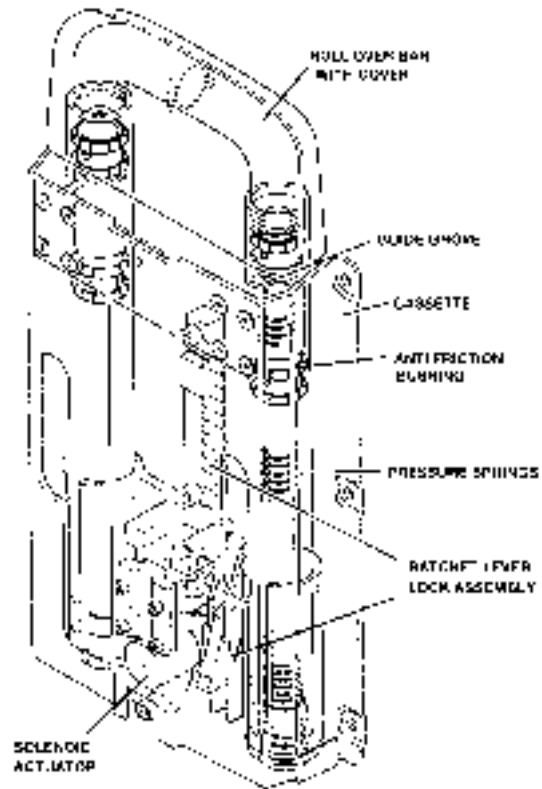
Emergency Release

As mentioned previously, the rollbars must be in the deployed state when replacement is required. If the bars can not be released via the diagnostic equipment, an emergency release mechanism is provided.

There is a small hole in the actuator to release the bar. A small screwdriver can be inserted to release each bar.

Each actuator lever has an overlap of 1.2mm. This is a critical dimension. Less than 1.2mm, the bars will deploy.

Note: Serious injuries could result from attempting to remove the rollbars in an armed state. Inadvertent deployment could occur causing injury.

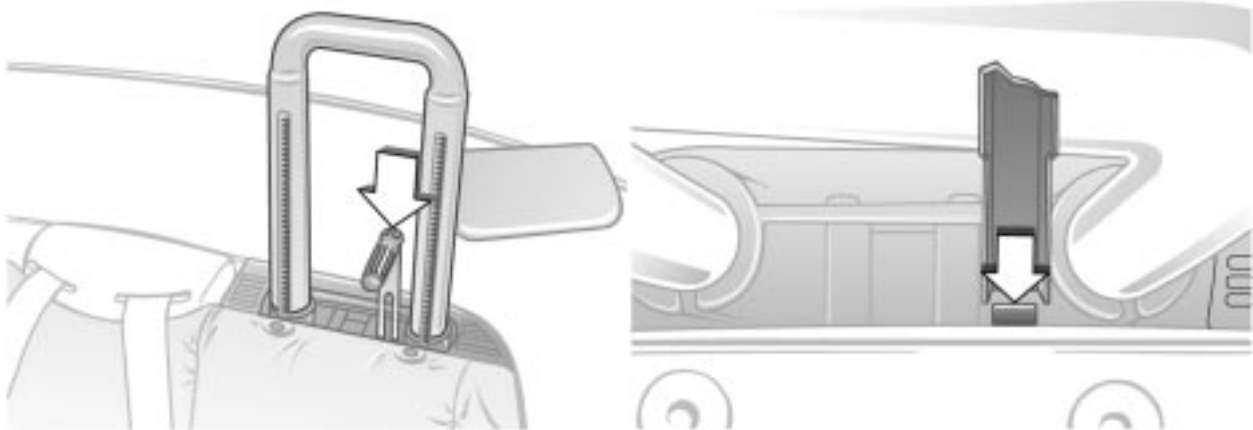


Retracting of the Rollbars

Once the rollbars have been deployed, the rollbars need to be reset (if they are not damaged). In contrast to the E46 and E64, the E36 requires a special tool which can be found in the vehicle tool kit.

The reset procedure is as follows:

- Remove the rear seat head rest(s)
- Insert the tool in the slot at the front of the roll bar
- Press the tool down to release the ratchet lock of the locking lever
- Push the roll bar down far enough to clear the ratchet
- Remove the tool and press the roll bar down until it locks into the actuator



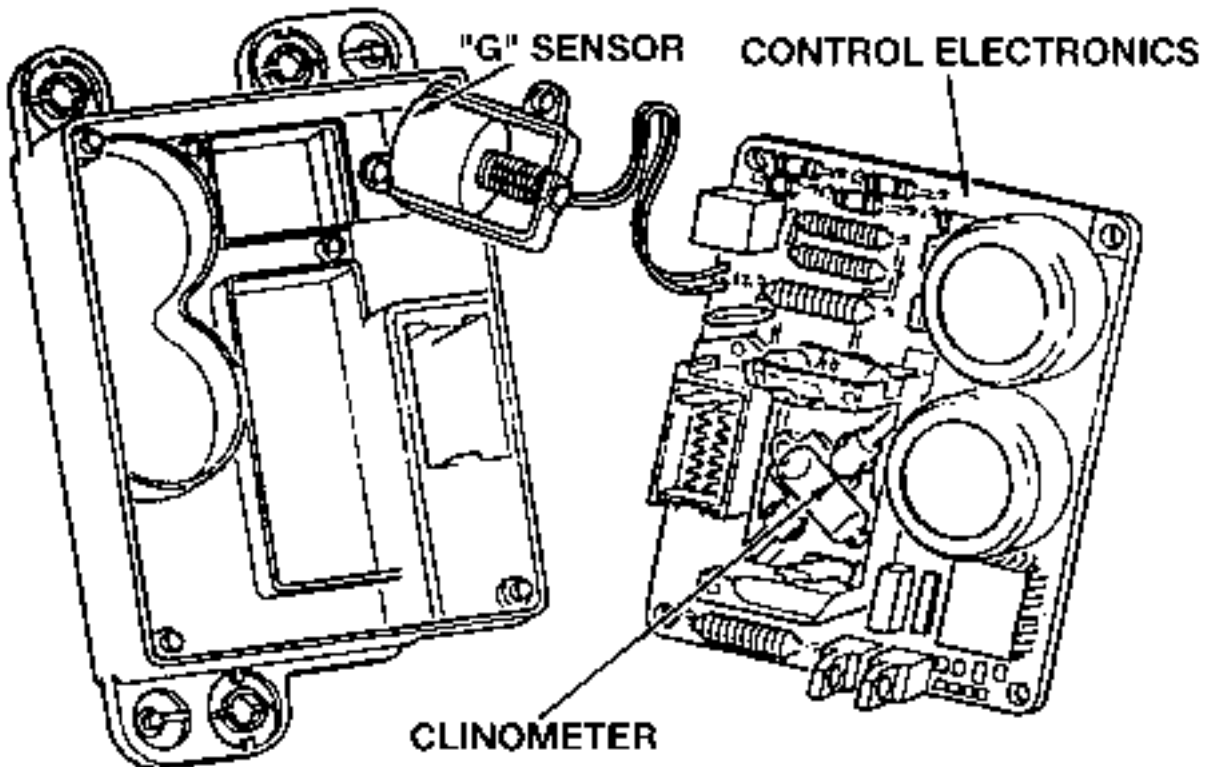
Rollover Sensor

The rollover sensor is mounted on the longitudinal axis of the vehicle, behind the left backrest. It contains the clinometer and g-sensor as well as the control electronics for roll bar deployment.

The rollover sensor is also connected to the diagnostic link for component activation and fault code diagnosis.

There are capacitors for triggering the rollbars in the event of an electrical failure.

Refer to the E46 RPS section for operation of the clinometer and G-sensor.





Classroom Exercise - Review Questions

1. What special tool is required to reset the rollover bars on the E46iC?

2. Which vehicles use rigidly fixed rollover bars?

3. What components are contained within the URS on the E46iC?

4. What precautions should be observed during URS installation on the E46iC?

5. To which bus system is the URS connected?

6. What is the G-sensor used for in the E46iC?



Classroom Exercise - Review Questions

7. Which of the following vehicles uses “rigidly fixed” rollover bars?
A. E46 B. E52 C. E64 D. E63
8. Which of the following statements is **NOT** true regarding RPS on the E64?
 - A. The sensors for rollover detection are located in the SGM.
 - B. The SGM controls the actuator circuits for the rollover bars.
 - C. The SFZ-R contains two processors to calculate rollover protection data.
 - D. The rollover bars can be reset without the use of a special tool.
9. Which of the following components allows the rollover bars to be deployed when there is a power loss?
A. Clinometer B. G-Sensor C. Capacitors D. Actuators
10. What feature works in conjunction with the RPS rollover bars to provide a sufficient survival space for the vehicle occupants during a rollover?

Notes:
